

Patent Claims

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1. Projection exposure apparatus for microlithography,
having an illumination device (12) for generating
5 projection light (13), a projection objective (20) with a
plurality of optical elements (L1 to L5; L5'), by which a
reticle (24) that can be arranged in an object plane (22)
of the projection objective (20) can be imaged onto a
photosensitive surface (26), which can be arranged in an
10 image plane (28) of the projection objective (20) and is
applied on a support (30), and having an immersion
device (42) for introducing an immersion liquid (34) into
an immersion space (50) between a last optical element (L5;
L5') on the image side of the projection objective (20)
15 and the photosensitive surface (26),

characterised in that

the immersion device comprises means (44; 66; 86; 90) by
20 which the creation of gas bubbles (48) in the immersion
liquid (34) can be prevented and/or gas bubbles (48) which
have already been created can be removed.

2. Projection exposure apparatus according to Claim 1,
25 characterised in that the immersion device (42) comprises
a suction device for extracting gas bubbles (48), which
has a suction gland (86) opening into the immersion
space (50).

30 3. Projection exposure apparatus according to Claim 1 or
2, characterised in that the support (30) can be displaced
in a scanning direction (84) of the projection exposure

apparatus (10), and in that the immersion device (42) has a side wall (32; 52) which at least partially bounds the immersion space (50) and is designed so as to substantially prevent at least lateral outflow of the immersion liquid (343) transversely to the scanning direction (86).

4. Projection exposure apparatus according to Claim 3, characterised in that the side wall (52) completely, preferably annularly, encloses the last optical element (L5) on the image side.

5. Projection exposure apparatus according to Claim 3 or 4, characterised in that an ultrasound source (66), by which the side wall (52) can be set in oscillation, is coupled to the side wall (52).

6. Projection exposure apparatus according to one of the preceding claims, characterised in that the immersion device (42) has circulation means for circulating the immersion liquid in the immersion space, which comprise a circulating pump (64), a filling gland (58) opening into the immersion space and a suction gland (62) opening into the immersion space.

7. Projection exposure apparatus according to Claim 6, characterised in that the circulation means have a degasser (44) for removing gas bubbles (48) from the immersion liquid (34).

8. Projection exposure apparatus according to Claim 7, characterised in that the degasser (44) has a preferably frustoconical run-off surface (74) arranged in an inclined

fashion, onto which immersion liquid (74) can be applied from above and over which a negative pressure can be set up.

5 9. Projection exposure apparatus according to one of Claims 6 to 9, characterised in that the support (30) can be displaced in a scanning direction (86) of the projection exposure apparatus, and in that the support (30) is arranged with respect to the projection objective (20) so as to reduce the extent of the immersion space (50) perpendicularly to the image plane (28) along the scanning direction (86).

10 10. Projection exposure apparatus according to one of Claims 6 to 10, characterised in that the circulation means are integrated into the projection objective (20), preferably in a frame (46') of the last optical element (L5) on the image side.

20 11. Projection exposure apparatus according to Claim 1, characterised in that the photosensitive surface (26) is held in a closed cassette (90) completely filled with immersion liquid (34), in the object-side wall of which the last optical element (L5') on the image side of the projection objective (20) is held so that it can be displaced in a direction (84') parallel to the image plane (28).

30 12. Projection exposure apparatus according to Claim 11, characterised in that the object-side wall is designed so that the volume filled with the immersion liquid (34) in the cassette (90) does not change when the last optical element (L5') on the image side is displaced.

13. Projection exposure apparatus according to Claim 11 or 12, characterised in that the objective-side wall is designed as a bellows (92).

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14. Projection exposure apparatus according to one of the preceding claims, characterised in that a flushing liquid different from the immersion liquid can be introduced into the immersion space by the immersion device.

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15. Projection exposure apparatus according to Claim 14, characterised in that the support (30) with the photosensitive surface can be replaced by a cleaning plate, which can be set in motion within a plane parallel to the image plane.

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16. Method for introducing an immersion liquid into an immersion space (50) which is formed between a last optical element (L5) on the image side of a projection

20 objective (20) of a projection exposure apparatus (10) for microlithography and a photosensitive surface (26) to be exposed, which is applied on a support (30),

characterised by the following steps:

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a) wetting the photosensitive surface (26) and the last optical element (L5) on the image side with immersion liquid (34), the support (30) being outside the beam path of the projection exposure apparatus (10);

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b) bringing the support (30) up to the last optical element (L5) on the image side in a movement parallel to an image plane (26) of the projection

objective (20), so that the immersion liquids (34) lying on the last optical element (L5) on the image side and on the photosensitive surface (26) touch;

- 5 c) introducing the support (30) completely into the optical path in a movement parallel to the image plane (28), until the support (30) reaches the required position for exposure.